

Physical Operators

Task

(refer to the handouts for the full exercise)

- What is the cost (in disk I/O's) of computing $R \bowtie_{R.A=S.B} S$ using the tuple-based nested loop join?

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- What is the cost (in disk I/O's) of computing $R \bowtie_{R.A=S.B} S$ using the tuple-based nested loop join?

$$B(S) + T(S) \times B(R) = 2000200$$

That is:

1. the cost of reading S block by block, fetching its tuples, plus
2. for each tuple for S the cost of reading R block by block to find each matching tuple.

Had we chosen R as the outer relation, the cost would have been higher.

- What is the minimum number of buffer pages required for this cost to remain unchanged?

2

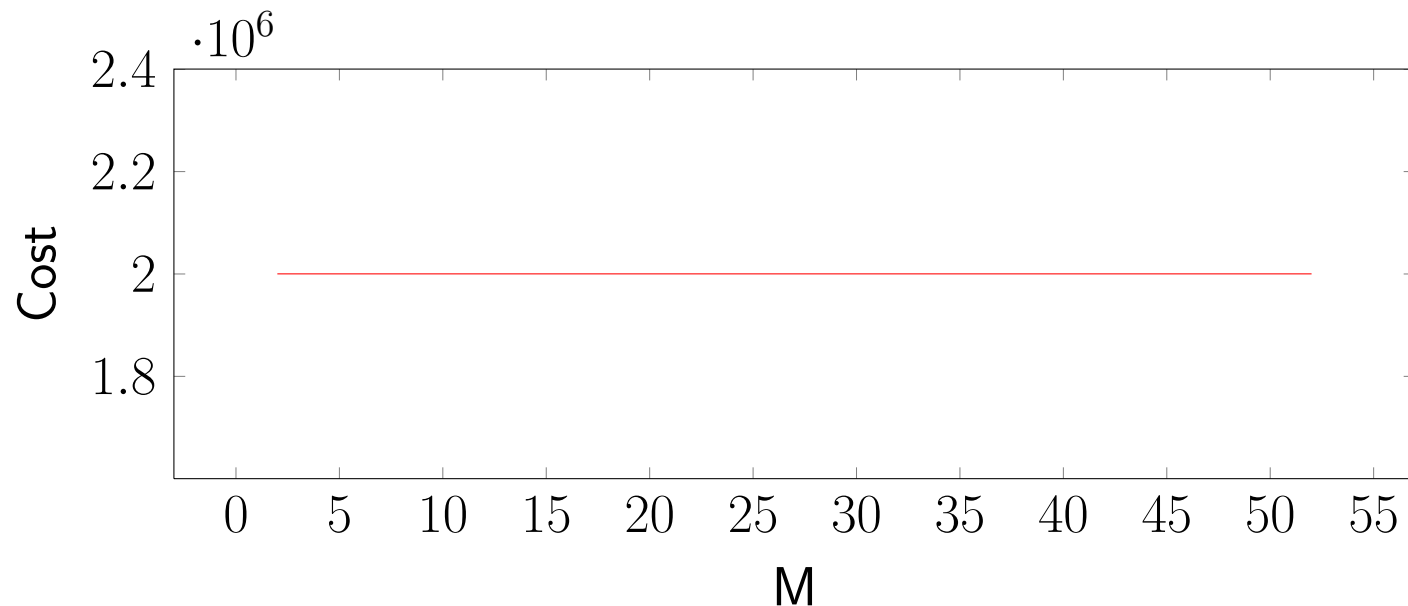
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- What is the cost (in disk I/O's) of computing $R \bowtie_{R.A=S.B} S$ using the block-based nested loop join?

$$B(S) + B(R) \times \left\lceil \frac{B(S)}{M - 1} \right\rceil = 4200$$

If we consider R to be the “outer” relation, the cost will be higher.

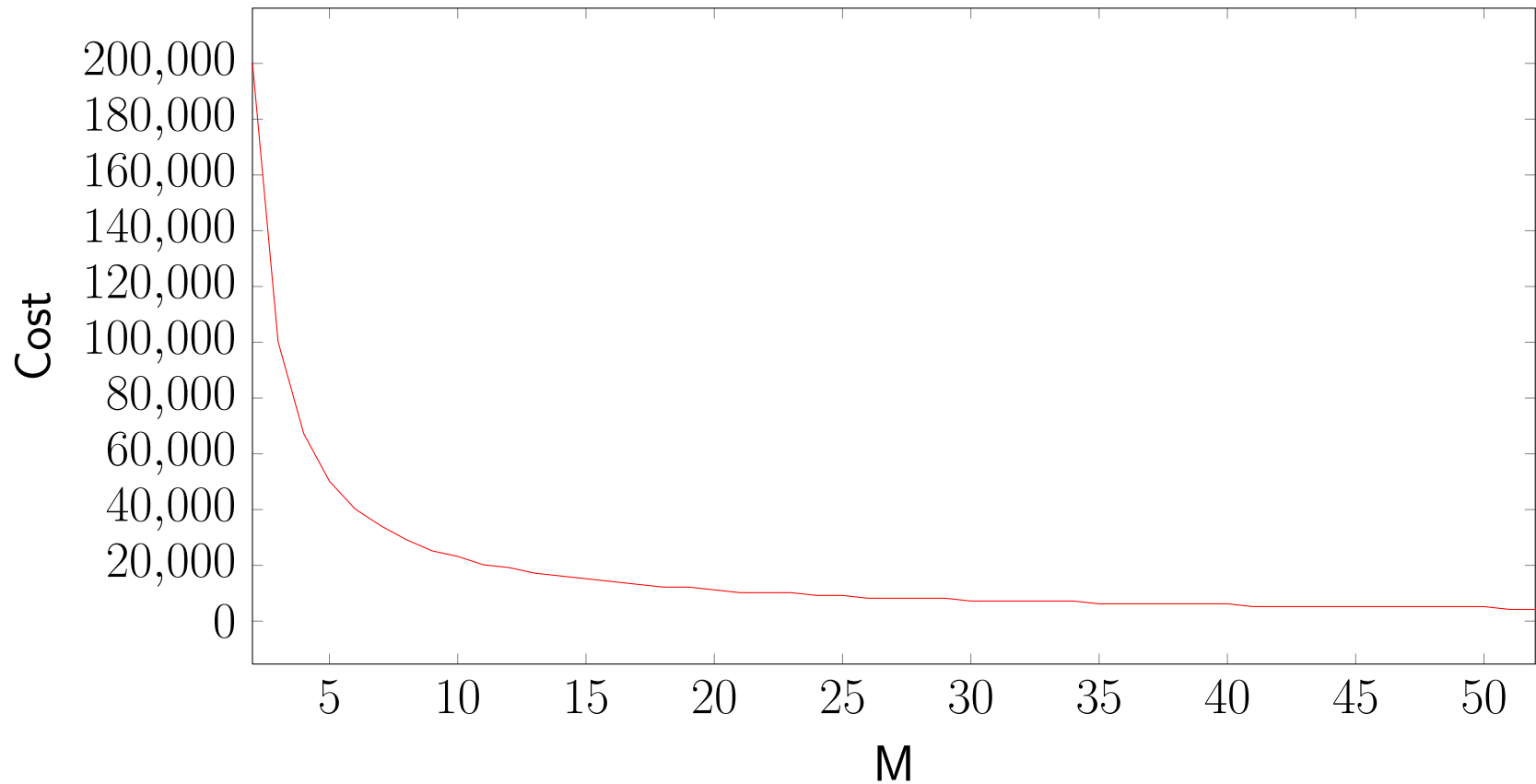
- What is the minimum number of buffer pages required for this cost to remain unchanged?

51

Physical Operators

Task

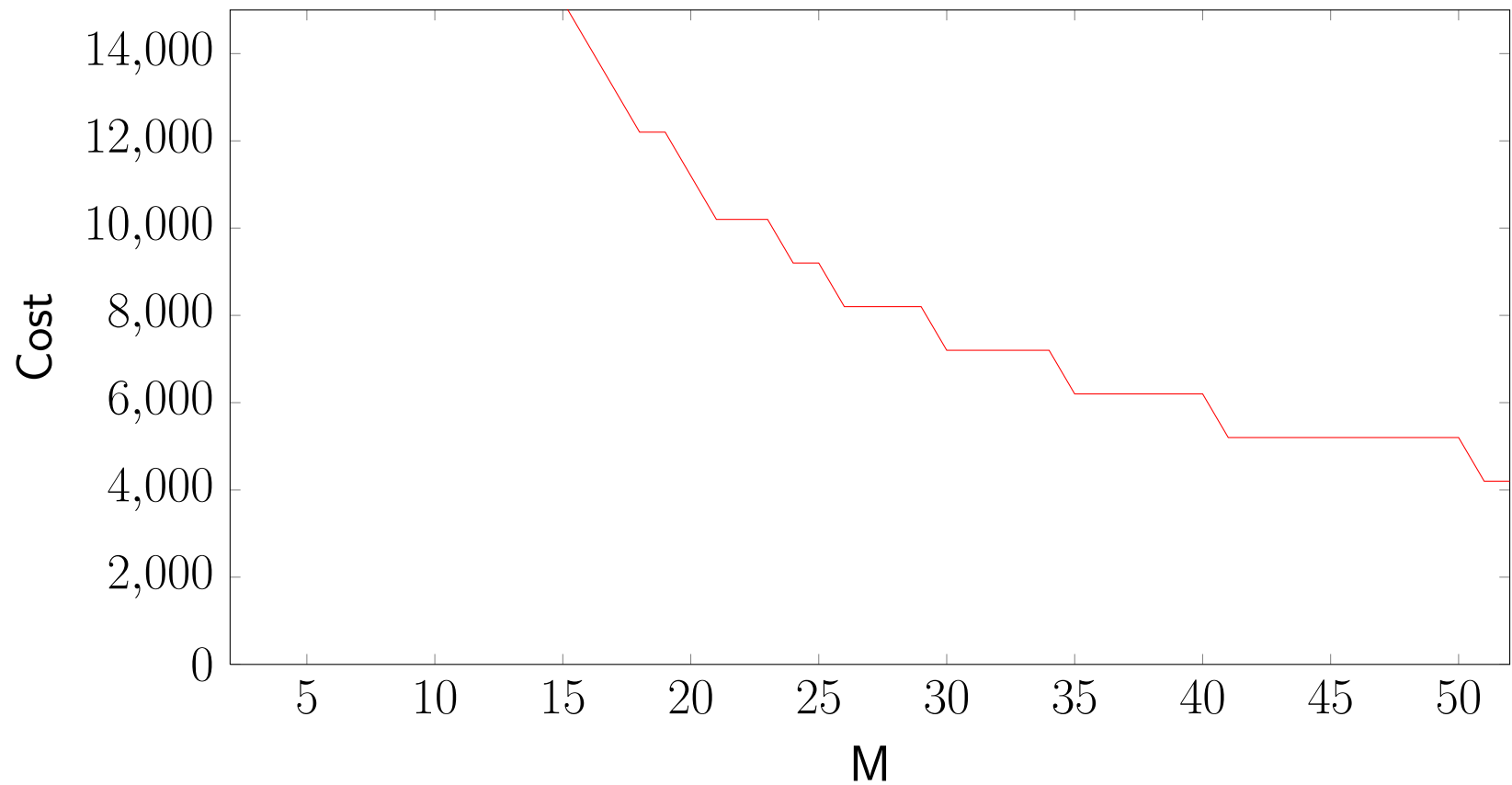
Plot of $B(S) + B(R) \times \left[\frac{B(S)}{M-1} \right]$ against M



Physical Operators

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Plot of $B(S) + B(R) \times \left\lceil \frac{B(S)}{M-1} \right\rceil$ for $M > 15$



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(refer to the handouts for the full exercise)

- What is the cost (in disk I/O's) of performing $R \bowtie_{R.A=S.B} S$ using a sort-merge join?

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(refer to the handouts for the full exercise)

- What is the cost (in disk I/O's) of performing $R \bowtie_{R.A=S.B} S$ using a sort-merge join?

$$\begin{aligned} & 2B(R) \lceil \log_M B(R) \rceil + 2B(S) \lceil \log_M B(S) \rceil - B(R) - B(S) \\ &= 2 \times 1000 \times 2 + 2 \times 200 \times 2 - 1000 - 200 \\ &= 3600 \end{aligned}$$

- What is the minimum number of buffer pages required for this cost to remain unchanged?

The aforementioned join is computed in two passes. After one sorting pass, we can merge the whole relations:

$$\frac{B(R)}{M} + \frac{B(S)}{M} \leq M$$

The minimal M that satisfies this is:

$$35 = \sqrt{B(R) + B(S)}$$

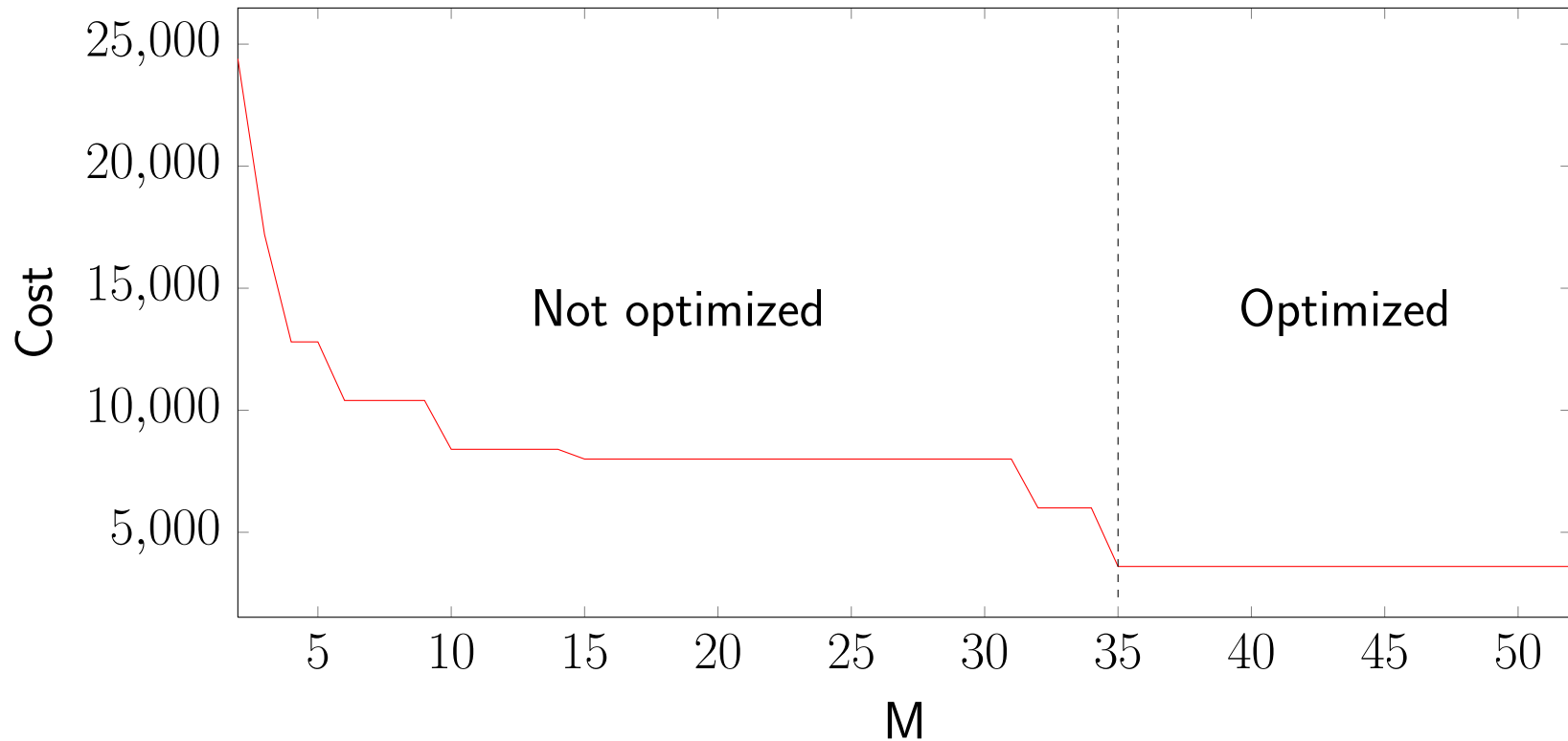
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Plot of the I/O cost of the sort merge join as a function of M

$$2B(R) \lceil \log_M B(R) \rceil + 2B(S) \lceil \log_M B(S) \rceil - B(R) - B(S), \quad M \geq 35$$

$$2B(R) \lceil \log_M B(R) \rceil + 2B(S) \lceil \log_M B(S) \rceil + B(R) + B(S), \quad M < 35$$



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(refer to the handouts for the full exercise)

- What is the cost (in disk I/O's) of performing $R \bowtie_{R.A=S.B} S$ using a hash join?

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(refer to the handouts for the full exercise)

- What is the cost (in disk I/O's) of performing $R \bowtie_{R.A=S.B} S$ using a hash join?

$$\begin{aligned} & 2B(R) \lceil \log_{M-1} B(S) - 1 \rceil + 2B(S) \lceil \log_{M-1} B(S) - 1 \rceil + B(R) + B(S) \\ &= 2 \times 1000 \times 1 + 2 \times 200 \times 1 + 1000 + 200 \\ &= 3600 \end{aligned}$$

- What is the minimum number of buffer pages required for this cost to remain unchanged?

The aforementioned hash join is performed in 2 passes. After one pass of hashing S , we must have buckets of a size that is at most $M - 1$:

$$\frac{B(S)}{M - 1} \leq M - 1 \Leftrightarrow M^2 - 2M + 1 - B(S) = 0.$$

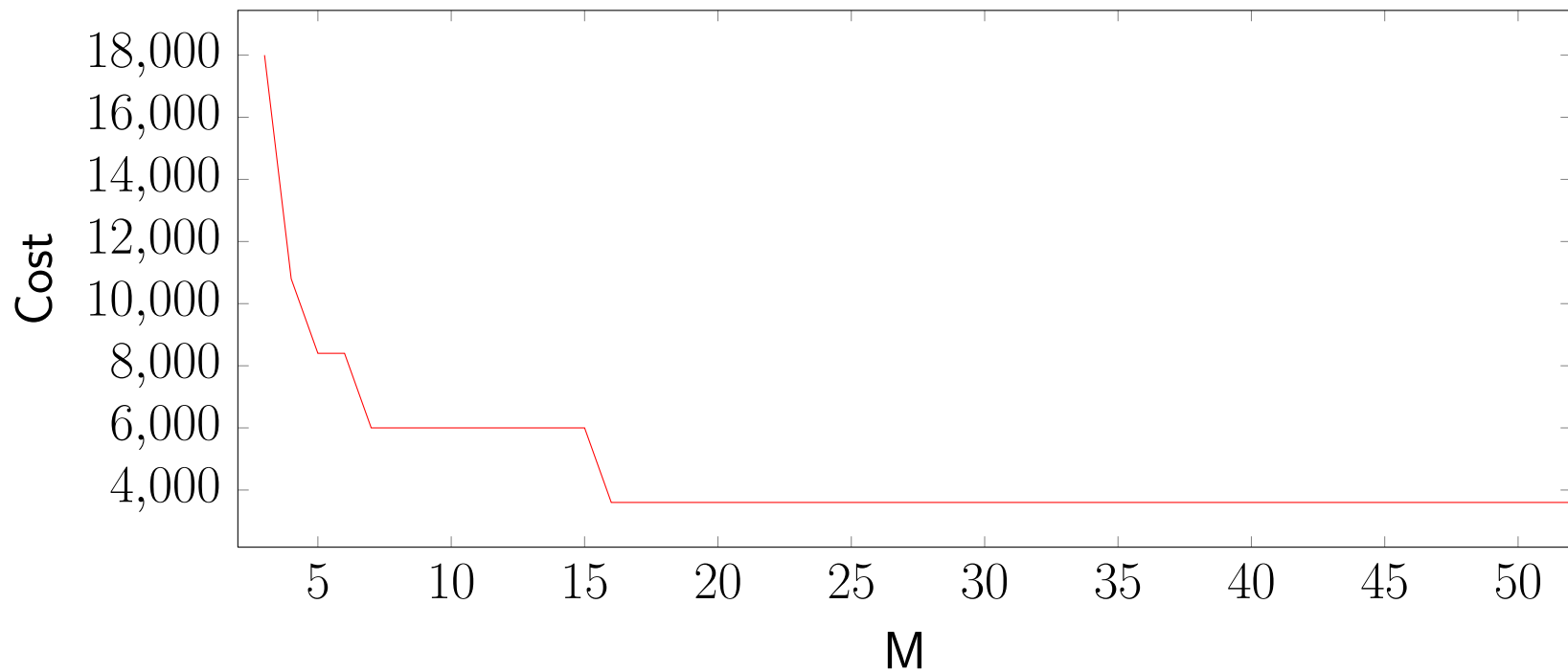
The minimal M that satisfies is (positive root of the quadratic polynomial):
 $\lceil 1 + \sqrt{200} \rceil = 16.$

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Plot of the cost of the hash-based join as a function of M

$$2B(R) \lceil \log_{M-1} B(S) - 1 \rceil + 2B(S) \lceil \log_{M-1} B(S) - 1 \rceil + B(R) + B(S)$$



Note that we need at least 3 buffers (why?)

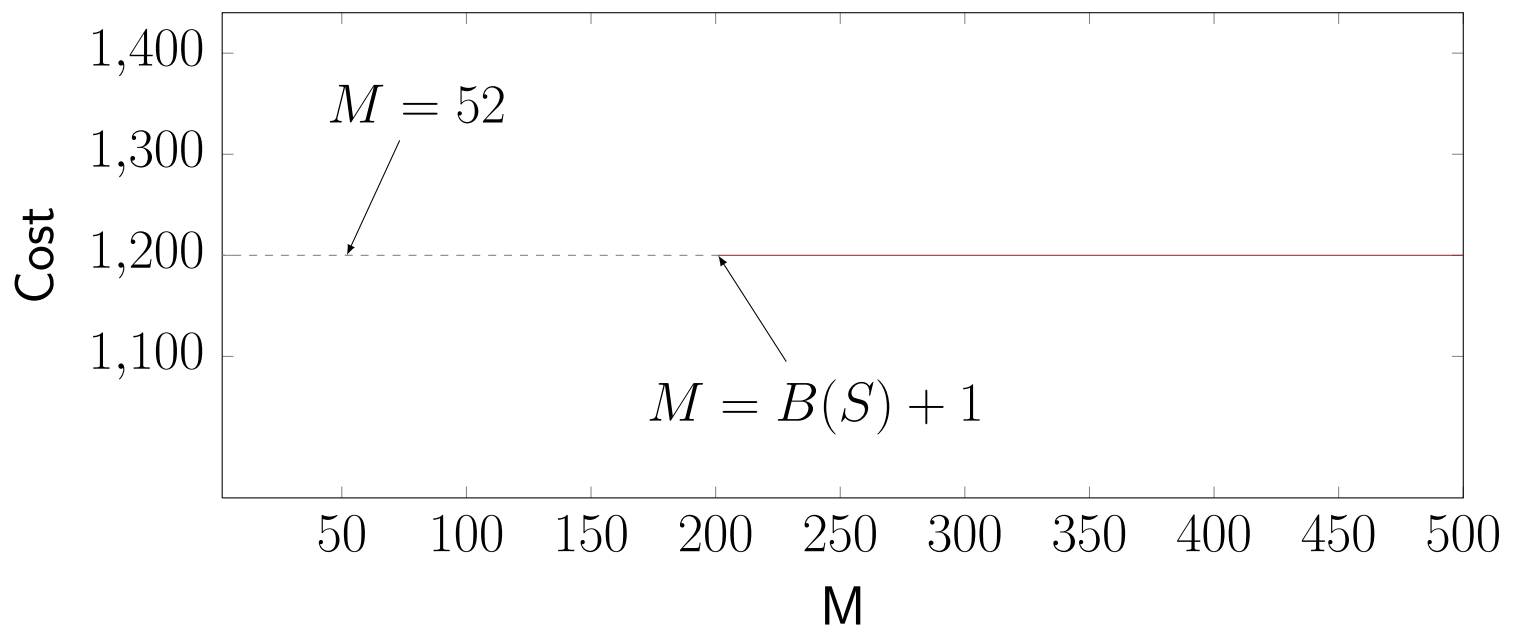
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- What join algorithm yields the least cost if you were free to choose the number of free buffers?

The single pass join. But You need $\min(B(R), B(S)) + 1$ buffers (why?)



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How many tuples does the join of R and S produce, at most, and how many blocks are required to store the result of the join back on disk?

Since B is a key of relation S , there is at most **one** matching tuple in S for each tuple in R . Hence, the maximal number of tuples in the join is $T(R) = 10000$.

A resulting tuple is at most as large as a tuple of R plus a tuple of S . Hence, we have at most 5 of these tuples per block. The maximal number of blocks in the output is therefore 2000